South Slough Bridge 91. This bridge has won several local and national awards for innovative design and construction techniques including the use of lightweight cellular concrete. It was a winner in the 2008 Portland Cement Association Bridge Awards program. For more information visit www1. co.snohomish.wa.us and search "Bridge 91."

Snohomish County Incorporates Sustainable Issues in Bridge Designs

by Darrell Ash and Kinyan Lui, Snohomish County, Washington

In 1976, Snohomish County began the development of our current bridge inventory system. At that time, nearly 90% of our bridges were made with timber. Since then, the county has focused on replacing and rehabilitating these structures using concrete. Currently, 62% of the county's bridges are made of concrete, 11% are steel, and only 27% of the bridges are timber. We construct three to four projects per year and maintain a total of approximately 200 bridges.

Both precast concrete bulb-tee girders and slabs are used, primarily because they are quickly erected, allowing faster access for vehicles. Excellent quality control is also a feature of the factory-cast process and materials are readily available in the local area. Several manufacturers of precast components are located in and around Snohomish County, which shortens the time from bid to production and delivery.

Climate Leads to Concrete

Concrete's durability is another key reason that it has become the primary construction material for our bridges. The Pacific Northwest receives a lot of rain all year, which causes timber bridges to rot and steel bridges to rust. A bridge's life-cycle cost has become a critical factor in determining what material to use. Typically, precast concrete is the most economical when all factors are considered.

Initial in-ground costs can be deceiving. Strictly speaking, timber bridges are the cheapest to build, but they won't last as long as precast concrete bridges, and they will require far more maintenance, increasing their total operating cost. As a result, we gravitate to precast concrete unless otherwise dictated, because, historically, it has had the cheapest life-cycle cost.

Global Warming Adds Challenges

The growing desire for a 100-year service life has created an additional factor when we design bridges and decide on pier locations. We anticipate that river channels will migrate over the decades as a result of global warming and we need to do the best possible job of predicting how the rivers will perform and where scour areas will occur. With this in mind, we place piers to minimize impact throughout the life-span of a bridge.

Innovative Use of Cellular Concrete

Although most of our bridges are fairly standard construction, in 2007 we completed a unique project that widened a two-span concrete Luten arch bridge built in 1918. The new deck is 62% larger in area with precast concrete slabs, which would have added a substantial amount of weight to the bridge. To counterbalance the additional dead load, the soil inside the arches with a density of about 125 pcf was replaced with lightweight cellular concrete having a density of 30 pcf.

Load-distribution analysis and a well-planned construction sequence ensured the project was completed successfully, providing new life for an historic county bridge at a fraction of the cost it would take for total replacement. In addition, no environmentally sensitive area was disturbed during construction.

Darrell Ash is the manager and county bridge engineer for the Construction Group, and Kinyan Lui is supervisor of the Bridge Design Group for Snohomish County, Wash.

North Fork Stillaguamish River Bridge 424. Nearly 95% of the county bridges cross water, and virtually all of those waterways impact endangered species.

Sustainability

Environmental concerns are another important factor to be considered. Nearly 95% of our bridges cross water and virtually all of those waterways impact endangered species. This means that we absolutely do not put piers into the water unless there is no other option. We also strive to minimize environmental impacts during construction by doing as much work outside the water as possible and coordinating with the permitting agencies at an early stage. The environmental process of a bridge project, including mitigations and permitting, can take more time than the design and construction phases.